BATAVIA FACING TROPICAL SEDIMENTATION: THE WATER MANAGEMENT OF THE DUTCH COLONIAL CITY IN THE ASIAN MONSOON TECTONIC ZONE

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Abstract

Batavia was the colonial port city founded by the Dutch United East India Company in the Ciliwung River Delta of West Java located in the Asian Monsoon Tectonic Zone. Construction of the urban area and land reclamation of the environs were conducted under the water management based on waterways having multi functions such as self-defense, transportation, drainage, water storage and irrigation. This research illustrates changes of the space and the water management of Batavia in the 17th and 18th centuries, paying attention to geomorphologic and hydrological difference between the Netherlands and Java Island. Moreover, the space formation of 'Ideal City' from the viewpoints of flood defense structure, reasons for the vicious spiral of the soil sedimentation and several efforts for its countermeasures are discussed.

Keywords

Dutch United East India Company, Indonesia, Drainage, Civil Engineering, Space Structure

INTRODUCTION

Batavia was founded as a hub port and a military base of the Dutch United East India Company in 1619 to secure the interregional trading in Asia. The location of Batavia was the center of the shoreline facing a big bay and the mouth of the Ciliwung River in the northwestern coast of Java Island. In the course of the 17th and 18th centuries, its unique urban structure with waterways had been formed. Nowadays a part of those old urban heritages still remains, which are related to the drainage system to control floods that are very big issues in Jakarta today.

Those waterways and the urban structure based on them had been made up in Batavia before the modern civil engineering began to establish in the 19th century. Many theses have already mentioned the urban framework of Batavia was

constructed according to the traditional manner of urban design and water management that were dominant in the Netherlands in those times.[1] Moreover Blusse (1988) and Van der Brug (2000) illustrated environmental problems in Batavia that caused high mortality after 1730s in particular.

Nevertheless, natural conditions of the Netherlands and those of Java Island are different from each other. The Netherlands is located in the huge delta, and the one forth of the land is below the average sea level and two third might be inundated without any dikes and sand dunes. On the other hand, the Java Island is located in the Asian Monsoon Tectonic Zone having peculiar hydrological and geomorphologic features influenced by monsoon and tectonic activities. It has not been unidentified by any researches yet how the difference influenced the space structure and the water management of Batavia in the 17th and 18th centuries.

Putting focus on the hydrological and geomorphologic conditions of Java Island in compare to those of the Netherlands, this study put forward a hypothesis that the soil sedimentation was the influential phenomenon that caused severe floods and other environmental problems in Batavia under the rule of the Dutch United East India Company. Purposes of this article are (1) to illustrate characteristics of the urban space structure based on waterways and water management system of Batavia,

(c) to explain the situation of soil sedimentation faced by the authority of Batavia,

(d) to analyze reasons of the vicious spiral of soil sedimentation, and (4) to consider significance of these aspects from historical points of view.

1. NATURAL CONDITIONS OF WEST JAVA

Java Island belongs to the tropical rain forest climate and has two main seasons consisting of the rainy season and dry season owing to the shift of the west monsoon and the east monsoon. Moreover, it is located at the junction of two major tectonic belts, the Alpine Belt and the Pacific Ring Belt. Mushiake (2001) named the Asian Monsoon Tectonic Zone for the region including Java where natural conditions influenced by the monsoon and tectonic activities are remarkable, for instance seasonal heavy rain, relatively short and steep rivers, rapid currents of river floods delivering soil from mountainous upper basins, formation of several kinds of small scale alluvial land like deltas, natural levees and alluvial funs.

Figure 1 shows main rivers, mountains and geomorphology of environs of Batavia covering Jakarta metropolitan region (JABODETABEK regions) today that is around 6400 . About 80 km width of the region from the northern coast has mountains including volcanoes of 3000 meters class in the south, the alluvial fun stretching northwards from the foot of the mountains and the delta along the coast. The Ciliwung and the Cisadane are rivers that connect the Java Sea and the pivot of the alluvial fun. The central area of Jakarta that was called Weltevreden in the colonial times is located at the borderline of the alluvial fun and the delta. Two kinds of alluvial landform dovetail there, where the edges of the alluvial fun are around 5 to 10 meters high and low lands of the delta are less than 3 meter above sea level. [2]

[1] Blusse(1988), Brommer(1992), Raben(1996), Funo(2005) and Bondan(2011)

[2] This explanation is based on the description of Verstappen (1953).

Monthly average precipitations in Jakarta change from 50 mm in August to 348 mm in January, and the annual average rainfall is about 1800 mm.[3] The most amount of precipitation in 24 hours recorded 286 mm in 1892.[4] Furthermore, in the mountainous upper basin the annual rainfall is about 4500 mm. In Jakarta big floods take place in January and February. The difference between the average high tide level and the average low tide level is relatively small, 0.65 meter on the coast of Jakarta.[5]

In compare to West Java, the large part of the Netherlands is located in the huge delta of relatively stable structural plain. The highest point in this country is only 322 meters high. The annual average precipitation in Amsterdam is 914 mm including the least monthly average rainfall of 46 mm and the most one of 100 mm.[6] The change of the tide level is relatively big in the Netherlands. The difference between the average high tide level and the average low tide level is around 1.5 meters, and the storm surge often makes the tide level rising up to 3 or 4 meters above the average sea level in January and February, which causes sea dike broken and severe flooding.[7]

The annual sediment load of rivers in every countries and regions can be related to the amount of the soil sediment and the speed of the soil sedimentation. Some comparative studies on this have already described that rivers in the archipelago of Southeast Asia have relatively high annual sediment loads in the world.[8] Comparing about 3.5 ton/ year in the mouth of the Rijn River in the Netherlands, the Ciliwung River has 1800 ton/ year at Kalibata of the middle of the river in Jakarta.[9]

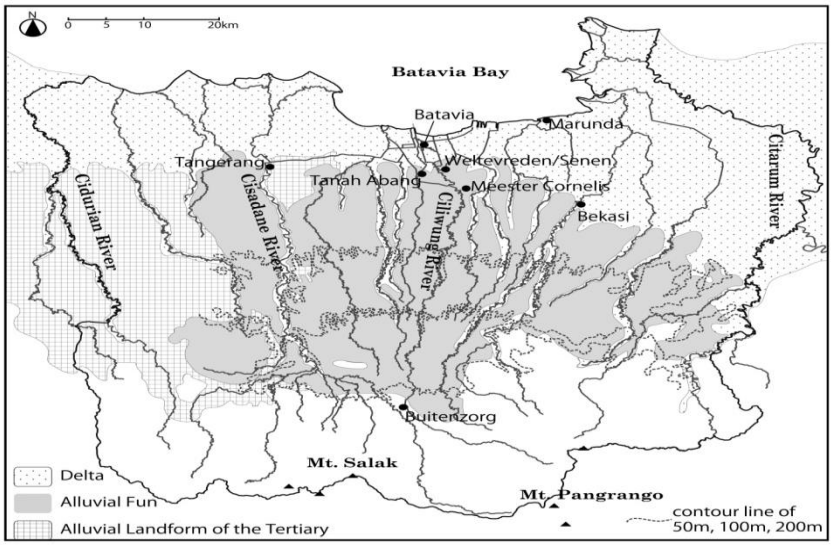

Figure 1. Geomorphology, Rivers, Mountains, Bay and Name of the Important Places

3) Weer (1994), Lampiran I

4) Bataviaasch Nieuwsblad, 2 February 1923

5) NEDECO (1973), p 17

6) Koninklijk Nederlands Meteologisch Instituut (2012)

7) Van de Ven (2004), p 35

8) Holeman (1968) and Avijit Gupta (1994)

[9)] Holeman (1968), p 743 and Departemen Pekerjaan Umum (1996), pp 2-11

2. SPACE TRANSFORMATION OF BATAVIA FROM 1619 UNTIL 1799

The urban construction of Batavia was started by the Dutch United East India Company in 1619, and the company was dissolved in 1799 when the urban center of Batavia had lost its centripetal force from view points of demography and social activities because of the environmental deterioration. Based on maps, descriptions and illustrations of publications, the process of the space transformation of Batavia and its environs under the rule of the company can be divided into five periods according to characteristics of space structure, land use and development of waterways. Figure 2 shows illustration of urbanized areas, main rivers and waterways, a coastline, city walls, a pier, forts and so on, which can explain those characteristics in each period.

In those times, the *stad* in the Dutch meant the urbanized area surrounded by city walls. In addition the *voorstad* and the *Chineese Camp* outside the walls also can be recognized as urbanized area. Besides, the *ommelanden* meant environs of the *stad*. In the second half of the 17th century the region from the Cisadane River in the West to the Citarum River in the East had already been put under the rule of the company including mountains in the South, so that Batavia's *ommelanden* was extensive. The following descriptions explain the transformation from 1619 until 1799.

The beginning of the *stad* formation: 1619-1630

Jan P. Coen heading fleets of the company began to construct the fortress and facilities for the military and the trading at the mouth of the Ciliwung River in 1619 after the destruction of the indigenous trading center, Jayakarta. The *stad* was formed southward from the fortress and it was surrounded by protective fences and the outer ditches on the east side of the river. It is clear that the space from the fortress to the city hall was designed with an axis. Along the direction of this axis and the orthogonal axis the urban areas were developed with waterways and streets by rectangular coordinates. The cost of these public works was covered with the poll tax of the Chinese inhabitants, trading taxes and sometimes the shared expense of the Chinese.[10] Regulations on fire prevention, building materials and garbage collection were made by the authority of the company.[11]

The completion of the *stad* formation: 1630-1645

Around 1632, construction of the *stad* began on the west side of the river and the whole *stad* was shaped according to the rectangular coordinates. It was surrounded by the city walls with small forts and a gate and outer moats. The inner area for public buildings and settlements were divided by canals and streets. It is prominent that the course of the river was straightened along the direction of the axis. But the coastline had moved seawards, so that the pier was extended with shared expenses of the company and residents.[12]

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[10] Chijs (1885-1897), Deel I, pp 76-77, 109-110 and 114-1115

[11] Chijs (1885-1897), Deel I, pp 60-61, 240-241 and 252-253

[12] Chijs (1885-1897), Deel I, p 433

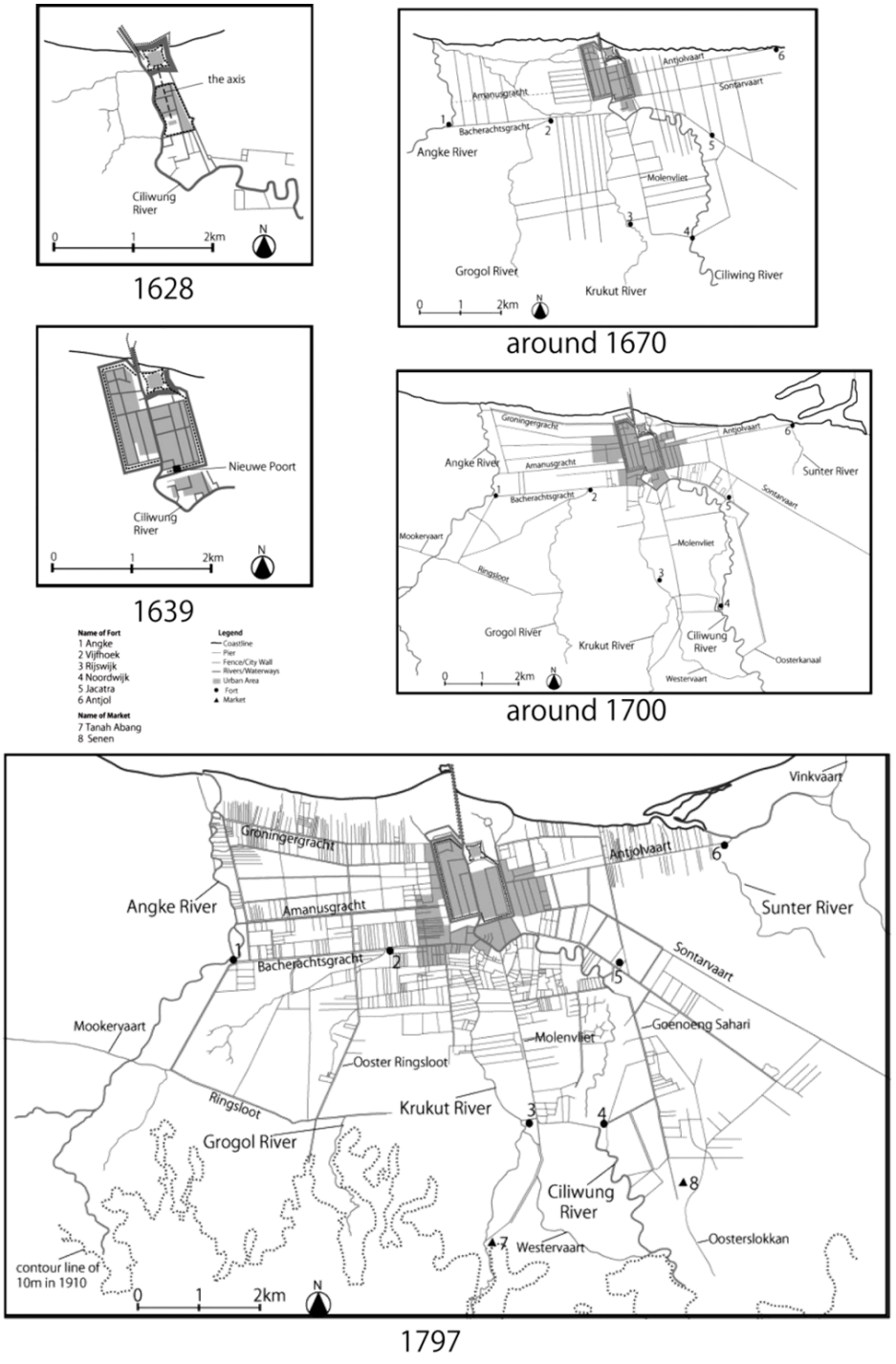

Figure 2. Transformation of Batavia

The beginning of the reclamation in the *ommelanden*: 1645-1680

After the peace agreement between the company and native kingdoms in 1645 and 1646, reclamation in the *ommelanden* began with digging canals and ditches. The forts were placed at the edges of main canals and these forts formed the first defense

line of the *ommelanden*. The new gates were added at both the east and the west of city walls, which showed settlements in the suburbs were developed. The *kampung*, native settlements or colonies increased, in which the most of inhabitants consisted of one of ethnic groups.

The development of the reclamation in the *ommelanden*: 1680-1730

Until 1680 the newly built forts at Tangerang, Meester Cornelis and Marunda were considered to be the so-called second defense line to protect the more extensive land of the *ommelanden* of Batavia. The cultivation of sugarcanes and the sugar manufacturing were developed in the wider environs, but deforestation was carried further owing to the reclamation works and utilization of woods for fuel of the sugar manufacturing. The new canals, especially Mookervaart and Ringsloot were dug in order to promote transportation and more efficient land use. The *kampung* and the *voorstad* expanded rather in the *ommelanden*. In 1699 the Mount Salak erupted and the large amount of volcanic sediment suffered rivers and waterways in Batavia and its environs. The shoreline moved seawards much because of the delivered sediment.

The develompemnt of settlements in the *ommelanden*; 1730-1799

In around 1733 the mortality of people in Batavia increased rapidly. The Chinese massacre in 1740 was also a big issue from social and demographic points of view. Frequent floods and epidemics deteriorated social circumstance in Batavia. Deforestation has made progress up to the higher land of mountains in the South. In Periangan that covers highlands in the south and the southeast of Batavia's *ommelanden*, the compulsory supply of commodity crops to the authority was promoted severely. The environmental deterioration of the *stad* and the neighboring area made inhabitants, in particular wealthy Europeans to move and build houses in suburbs. Some of them were mansions at healthier lands along the waterways and some were country residences in their private estates.

3. 'DUTCH IDEAL CITY'

In 1618, before the construction of Batavia had begun, *de Heeren XVII,* the highest decision-making board of the company in the Netherlands asked Simon Stevin, the prominent military engineer, to make designs of a fortress and a city for the new trading hub in Asia.[13] According to Raben (1996), the board wrote to Coen "to keep it dry during inundation by the river or the high tide of the sea, with good ditches, canals, and other drains [being useful as well] to transport commodities, as is done in the cities here [in Holland]".[14] Unfortunately the Stevin's design has not been survied. Similarities and differences between the real plan of Batavia and the model planning of the 'ideal city' proposed by Stevin were investigated by Funo (2005). The great efforts of the local authority in 1630s can be shown from the straightened course of the Ciliwung and the formation of space with canals, ditches streets, city walls and forts according to the rectangular coordinates. In around 1639 the *stad* had almost completed. It can be said that this urban structure appearing in the middle of 17th century was the 'Dutch Ideal City' not only because of the similarity with Stevin's model, of course, but also because of reasons from hydrological and landscape points of view.

As the above mentioned quotation described, the ground of the *stad* was filled and raised with soil taken from digging ditches. The ordinance of the local authority in 1637 noticed that residents of the specific streets must appropriately raise the ground of the streets and the banks of the canal along the streets and keep drainage from their sites and the streets well without any stagnation.[15] The masters of wards in the *stad* were also asked to keep drainage of streets in their wards adequate.[16] These managements indicates that the ground of the *stad* was kept slightly higher than the surroundings.

In addition, De Haan (1935) wrote that the sea level in spring tide became higher than the ground level of the *stad*, even though it was a rare case.[17] Based on maps and illustrations produced in the 17th century, it is supposed that the *stad* of Batavia had not been protected against floods, because there were neither dikes, nor dams, nor sluices having function to prevent inundations. Surroundings might be more often inundated than the *stad*. In other words, the *stad* had faced natural changes of the water level of both the sea and the rivers.

In the Netherlands, most of *stad* areas were protected with dikes, dams and sluices from the daily higher water level and also from the extreme high tide under storm surges. Only reclaimed lands outside dikes like the *Waterstad* in Rotterdam were the same as the whole *stad* in Batavia. The upper-class people in Rotterdam prefered to live in town houses at the Waterstad. This is why people chose good environment facing natural stream outside dikes without any stagnation like inside dikes, although they were sometimes suffered from floods at the first floor of their houses.[18]

The landscape of Batavia in those times also assists reasons for the 'ideal city'. The *stad* had the straightened Ciliwung River at the center along the direction of the long axis of the rectangular shape. The river could connect the land for urban activities with the sea and the upper basin. Ships could enter the *stad* without structured barriers like dams and sluices in the 17th century, which was, of course, controlled by the authority. People could be blessed with natural streams. Moreover, the company could make use of their advantage of the navigation and the navy force to maintain Batavia.

4. WATER MANAGEMENT IN BATAVIA

It was very crucial for the *stad* and reclaimed lands in Batavia to conduct water management and land use management. The space formation of Batavia and its suburbs with the network of waterways had been seen in the delta area, which was similar to the way in the Netherlands. In Batavia these waterways had multi-function such as self-defense, ship transportation, drainage, flood control, water supply for urban activities, irrigation for cultivation, facilities for amenity and so on. For instance the moats outside the city walls were dug not only for defense against attacks from native kingdoms, but also for ship transportation, drainage, flood control and water supply. When it rained, the moats accepted water drained from the *stad* and surroundings, and at the same time those kept water from rivers until if was drained to the sea according to changes of the tide. In the dry season in particular the moats were filled with water from other canals in the *ommelanden* using dams and sluices to control the water level.[19] That is why the water volume and the depth of canals in the *stad* was necessary to maintain ship transportation and loading at warehouses.

[13] Brommer (1992), p.7

[14] Raben (1996), p.11

[15] Chijs (1885-1897), Deel I, pp 413-414

[16] Chijs (1885-1897), Deel III, pp 160-161

[17] De Haan (1935), p 245

[18] Han Meyer (1999), pp 291-292

[19] A number of ordinances were announced to keep the water volume of waterways in de *stad* such as Chijs (1885-1897), Deel III, p 166 and Deel VI, p 537.

In the *ommelanden* it can be said that the polder system with the network of waterways was the foundation for space formation and socio-economic activities. The polder means reclamation and reclaimed lands based on drainage and land use system supported by water level control of waterways in the Netherlands. The waterways in the suburbs of Batavia were mainly dug after 1640s according to the rectangular coordinates that were almost the same as inside the city walls. The local authority under the company had made all efforts to control the development of the *ommelande*n, for example permission for construction of canals, dams and sluices, the collection of tolls, division of lands, shipping business and so on. The trunk line of waterways such as Amanusgracht, Antjolvaart, the former ditch of Molenvliet and Bacherachtsgracht were dug with the private initiative, but these were set up along the specific direction and the authority kept the permission for the digging with several advantages for the investigators. *Het Collegie van Heemraden*, the boad for management of the *ommelande*n was established in the latter half of the 17th century.[20]

The case of Sontarvaart can explain the situation of the polder system in Batavia well. This canal having 6 voeten (about 1.9 meters) in depth and 1.5 roeden (about 5.7 meters) in width was dug under the instruction of the local authority collecting the shared expense from landowners. The amount of the expense for every landowner was calculated according to width of a canal frontage of each land.[21] The person in charge collected tolls from those who passed the fixed point of the canal by a ship. Furthermore, the authority controlled the irrigation, determining the three locations of lock gates. Those who wanted to conduct water from the canal into their land had to pay charges to officials at the gates.[22]

With the aim of constructing and maintaining infrastructures including ditches, roads and bridges, the authority collected several kinds of taxes. Some were based on width of sites, some on appraisal value of sites. Surveyors who had official licenses in the Netherlands played an important role to measure lands and estimate the value. Most of them were employed by the authority to make plans and supervise the construction and the management.[23] It can be considered that they were the 'civil engineers' in the pre-modern times.

Water for the network of waterways in the delta was supplied from several natural rivers running from the alluvial fun and springs existing everywhere in the fun. In addition, artificial watercourses for irrigation were constructed from the pivot place of the fun in the middle of the 18th century. This system as a whole was called "*de binnenlandsche watergemeenschap*" that meant "regional water community" by Schram, a civil engineer who made the plan for flood control in Batavia in 1870s. He considered that the function of the waterways for ship transportation had priority in this system.[24] The natural rivers contributed water to the network, and the water saved in the network supported the ship transportation, which actually maintained the company itself.[25]

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1. Chijs (1885-1897), Deel II, pp 379-380 and Deel III, p 35

2. Chijs (1885-1897), Deel II, pp 434-435

3. Chijs (1885-1897), Deel III, pp 210-212 and pp361-363

23 Brommer (1992) and Zandvliet (1998)

24 Schram (1878)

25 Chijs (1885-1897), Deel VI, pp 537-538

5. SOIL SEDIMENTATION

Soil sedimentation is one of natural phenomena in the hydrological circulation. Needless to say, alluvial deltas and alluvial funs are formed by sedimentation of soil delivered by floods and high tide of the sea. In Java located in the Asian Monsoon Tectonic Zone in particular sedimentation is more active than in stable plain having no heavy seasonal rains. Eruption of a volcano, an earthquake, a mudslide and erosion of land yield mass earth and sand that form various kinds of alluvial land. Batavia is not an exception. But it is also closely related to human activities, which is the same as floods, because human activities like deforestation and change of land use may cause severer flooding and soil sedimentation.

Several evidences are able to describe the fact that Batavia was usually suffered from soil sedimentation in the 17th and the 18th centuries. First of all, it is obvious that the seaward movement of the coastline can be recognized from maps. When the *stad* of Batavia had been constructed in 1920s and 1930s, the shoreline had already been moving so that the north part of the fortress located in the sea at the beginning was surrounded by land as it can be seen in Figure 2. In the course of the 18th century the coastline had moved more evidently.

The secondary evidence is the description about natural disasters including soil sedimentation. It is famous that the eruption of Mt. Salak in 1699 caused all of waterways and rivers in Batavia filled with volcanic sediment. [26] De Haan, a historian in the first half of the 20th century, mentioned sedimentation after flooding of rivers and the high tide of the sea.[27]

The third one is a number of ordinances that often issued by the local authority of the company to instruct to dredge waterways. In 1634 the ordinance had already described dredged ditches that helped to improve sanitary condition in the *stad*.[28] Afterward, inhabitants and landowners were requested to pay the shared expense in order to dredge canals in which ships could not passed in 1643.[29] The eruption of Mt. Salak made situation grow more serious. Details are to be explained in the following chapter. But soil sedimentation can be found since the beginning of the city construction in the first half of the 17th century.

In the following century it seems evident that soil sedimentation had gotten worse because of man-made factors. As reclaimed lands had expanded for sugarcane plantations, paddy fields and cattle breeding in the *ommelanden*, trees of the tropical forest had been cut down. The forest had lost up to the high places of mountains in the south of the *ommelanden* except for the forest preserved by the company.[30] Floods getting more frequent caused severe sedimentation, too. Wastes from sugar industries and settlements accelerated sedimentation in the waterways in Batavia.

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[26] Chijs (1885-1897), Deel III, pp 458-460

[27] De Haan (1935), p 249 and p 251

[28] Chijs (1885-1897), Deel I, p363

[29] Chijs (1885-1897), Deel II, pp 29-31

[30] Teisseire (1792), p 3

Another man-made factor cannot be forgotten in concern to this problem. That is the decelerated current in the networked waterways and rivers. In general in an alluvial delta the speed of streams gets slow down owing to its flat surface and a countercurrent of the high tide, which is the real reason for delta formation. Besides, the artificial water network in Batavia had main function to keep water volume and depth enough for the sake of ship transportation and loading. Furthermore streams from the alluvial fun were divided into a few watercourses. These things reduced the speed of current, too. The network as a whole played a role to keep water as if it had been a huge reservoir. Regarding flood control, currents of rivers and waterways were diverged into newly dug floodways, and the original trunk streams remained as before. These efforts meant that new watercourses were added to accept increased currents, but the currents were rather decelerated because of decreased volume, which caused sedimentation.

The ordinance of 1788 described the unhealthy situation owing to the filled canals in Batavia. People believed at those times that harmful vapor went out from the sediment. The most of canals were not adequate to navigate. Those sediments dried up in the grater part of a year.[31] Terrible smell from the sediment decomposed under the high temperature and the strong sunshine pushed wealthy people to evacuate and look for healthy lands. The tropical climate and sedimentation combined to suffer the trading center of the company in decline.

6. COUNTERMEASURES AND THE VICIOUS SPIRAL

Such a lot of ordinances concerning dredging waterways showed the grate efforts for countermeasures managed by the local authority. As mentioned above, the authority had already announced the dredging in 1634 and 1643. It revealed the systematic way to collect the expense for dredging in 1643. The most of the expense was shared by inhabitants and landowners in the *stad* according to their comparative benefits and the rest was covered by contributions from wealthy Chinese and Dutch residents. The benefits for inhabitants and landowners were estimated allowing a location from waterways and a width of each site and ownership that is an owner or a tenant.[32] The width of sites had become the standard to collect the expense afterward, but in 1685 dredging of waterways was assigned to a master of a ward and the cost was taken in account according to an appraised value of each site and house.[33]

Nevertheless, immediately after the eruption of Mt. Salak, the ordinance instructed house owners and tenants to dredge canals and rivers in front of their houses with their own expenses both in the *stad* and in the *ommelanden*, because all of canals were filled up with the earth and the sand and not navigable.[34] The authority began to take a number of dredging workers from other territories and neighboring domains in Java.[35]

The ordinances concerning dredging had been announced intermittently until 1799, the year when the company was dissolved. The shared expense based on the appraised value of a

[31] Chijs (1885-1897), Deel XI, pp 11-13

[32] Chijs (1885-1897), Deel II, pp 29-31

[33] Chijs (1885-1897), Deel III, p 147

[34] Chijs (1885-1897), Deel III, pp 458-460

[35] De Haan (1935), p 255

property was replaced by new taxation that was based on a width of a site again in 1745. This taxation was intended to cost many kinds of infrastructures such as dredging canals, drink water supply, streetlights, garbage collection and maintaining sluices.[36] But after 1760s people in Batavia were asked to pay additional contributions based of the appraised value of their sites mainly to supplement the expense of dredging.

Another effort of countermeasure for sedimentation was tried in 1740s constructing new sluices to clean up water of canals in the *stad*. Water was kept making use of the rising tide inside the *stad* and afterward it was flushed away to the sea at the ebb.[37] This was similar to the way in Amsterdam where flushing had been effective. On the contrary, in Batavia this measures caused sedimentation.[38] Sluices became obstacles to streams and sediments accumulated at the foot of them, which hindered the motion of sluices.[39]

The ordinance to prevent soil erosion in the upper basin of the rivers can be also considered as a countermeasure. Owners of farmsteads along rivers in the ommelanden and in the neighboring highlands must plant trees on banks by width of 1 roede (3.8 meters) to 3 roeden (11.3 meters).

In spite of these ordinances, increasing floods accelerated sedimentation. The canal named Mookervaart connecting the Cisadane with the Angke in the west of Batavia brought frequent floods to Batavia in particular. Floods left large scale of sediment that made waterways filled up. Such waterways had less capacity to accept water in flood, which caused stagnant drainage and floods again.

The vicious spiral like this situation took the lives of many people. In 1733 a lot of workers digging a drainage canal after the catastrophic flood were dead probably because of unhealthy condition related to stagnant drainage.[40] Moreover dredging of waterways was fatal to so many workers. 68 out of 100 workers coming from other district in Java died in 1788, so that the local authority finally decided to abolish the employment of workers. [41] Van Breen, a civil engineer who made the water management plan in Batavia in 1910s pointed out that these historical cases showed that the deterioration of hydrological circumstance had something to do with the unhealthy condition in Batavia.[42]

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[36] Chijs (1885-1897), Deel V, p 185

[37] De Haan (1935), p 258

[38] Van Breen (1923)

[39] De Haan (1935), p 258

[40] Van Breen (1923)

[41] Chijs (1885-1897), Deel XI, p 136

[42] Van Breen (1923)

CONCLUSION

It seemed that the officials of the company, especially engineers dealing with public works had struggled to break through this vicious spiral. They recognized the hydrological difference between in the Netherlands and in Java, and they looked for the adequate ways for water management in Java along development of modern engineering.[43] It took more than 100 years until the full-scale water management plan based on modern engineering that Van Breen drew up for Batavia.

In these more than100 years from the beginning of the 19th century, several paradigm shifts had occurred in Batavia. First of all, urban central components such as administration and military facilities escaped from the old town surrounded by walls, following the wealthy people. The new authority chose the border of the alluvial fun and the delta. Some of waterways in the network keeping water were filled in. It can be said that people paid more attention to drainage in the new urban center rather than to keep water volume. The drainage canals based on the modernized engineering were constructed after 1870s in Batavia, but it took more time to find the more appropriate ways to manage the volume of currents and sedimentation in 1910s.

At the end, it needs to mention that this research cannot describe the traditional and local knowledge of the Indonesian people for water management. This is the remained subject to clarify in the future. In addition, this article would like to point out that the advantages of the network of waterways in Batavia should be reevaluated now. People could be involved in daily maintenance of canals and ditches, which would make them to be more aware of water quality, water management and flood control. People could make use of the amenity on banks of waterways and they would be blessed with water.

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